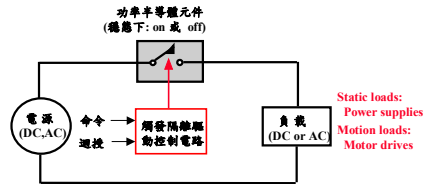


## 電力電子概要

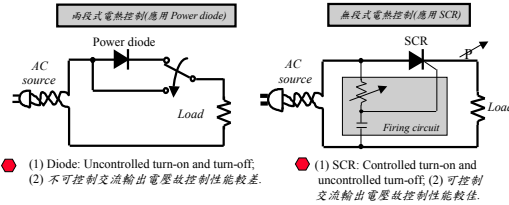
### 一、電力電子基本觀念

什麼是電力電子 (Power Electronics)? 一個電力電子系統係應用功率半導體元件, 將交流或直流電源輸入轉換成適當之電源供給負載並控制其受電功率, 以取代傳統之以機械式開關、自藕變壓器、可變電阻等組合調控負載功率之方式。其具有較高之效率、較靈活之控制變化性、無接觸污損、較少之維護及較廣之操作範圍等優點。下圖為電力電子系統之結構示意圖。



- ❑ 控制功率半導體元件之開關動作 → 調控由電源送至負載之功率
- ❑ 電力電子設備 → 功率調節單元 (power processing unit)
- ❑ 功率半導體元件當開關使用 → 損失小, 效率高

### 簡例(電熱調控)

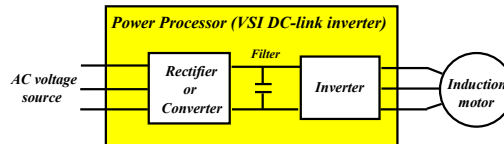


### 二、電力電子系統

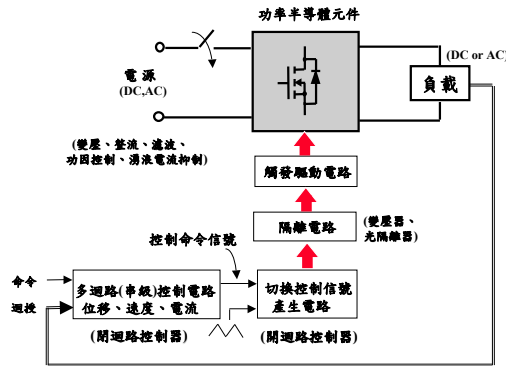
#### (一)、電力電子系統之定義:

為一功率處理器, 由一個以上功率半導體元件換流器組裝而成, 將輸入電源轉換調控成滿足負載所需之電源。

例子: Motor drive

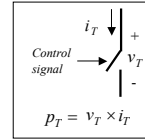


#### (二)、電力電子電路基本組成



(三)、可控開關 (Controllable Switches)之特性

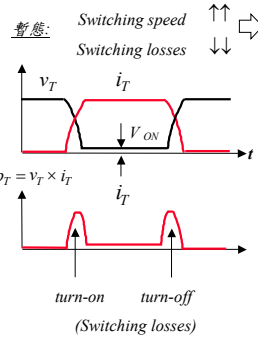
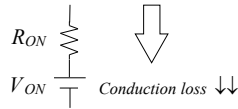
- 元件：(1) Forced-commutated SCR  
(2) BJT, MOSFET, IGBT, MCT, ...



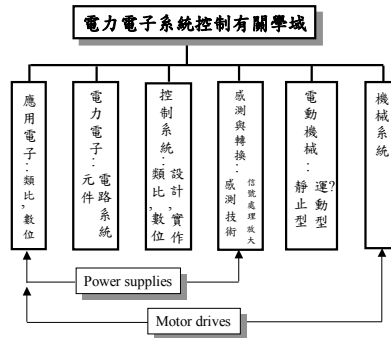
● 所欲之特性：

穩態：

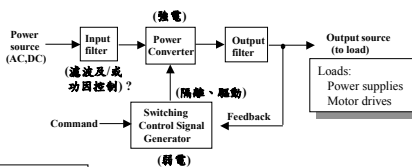
- (1) Off: Leakage current ↓↓
- (2) On:  $R_{ON} \downarrow \downarrow$ ,  $V_{ON} \downarrow \downarrow$



三、電力電子系統控制有關學域



四、功率換流器之典型結構



換流器之型式：

- 交流至交流交流至交流換流器(cycloconverter) (含交流至直流至交流換流器)
- 交流至直流換流器 (converter)
- 直流至交流換流器 (inverter)
- 直流至直流換流器 (chopper)

**五、電力電子系統種類**

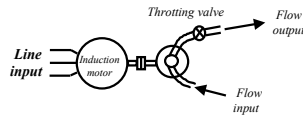
- (1) 電源供應器(Power supplies)
  - A. 應用 Switching converters.
  - B. 應用 Resonant converters.
- (2) 馬達驅動系統(Motor drives)
  - A. Speed drives.
  - B. Position servo drives.
- (3) 其它應用：
  - 分散式配電系統(Distributed power architecture, DPA)、不斷電電源供應器(Uninterruptible power system, UPS)、分散式發電源(Distributed generator, DG)配電系統、再生式電源(Renewable energy source, RES)配電系統、儲能系統、乏補償器、功因校正控制器、電子式日光燈及照明裝置、感應加熱器、電焊器、。

**六、電力電子系統之應用例**

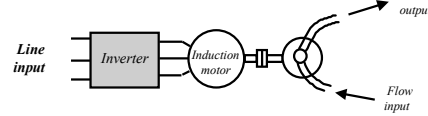
Residential (家用)、Commercial(商用)、Industrial(工業用)、Transportation(大眾運輸)、Utility systems(電力系統)、Aerospace(航太)、Telecommunication(電信)、其它。

**例子：Motor-driven pump system (ASD 之應用)**

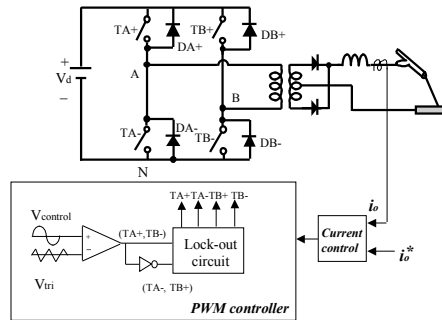
- ⊙ Pump load: Load torque  $T_L \propto speed^2$ , Load power  $P_L \propto speed^3$
- ⊙ 傳統方式



- ⊙ ASD (Adjustable Speed Drive): 省能



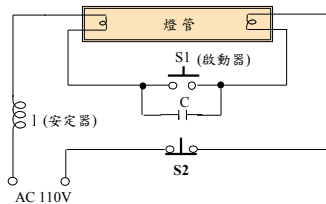
**例子：變流焊接機**



**例子：電子式日光燈**

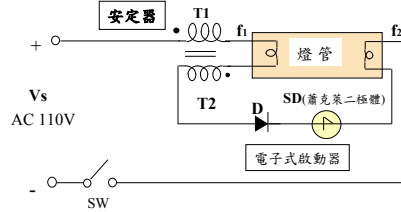
☒ 傳統日光燈：按鈕啟動式日光燈線路圖(110V,10W)

**安定器之功用：**啟動產生高壓點燈，點燈後限制燈管電流



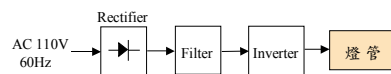
☒ 電子式啟動器

- 應用觸發元件(蕭克萊二極體)

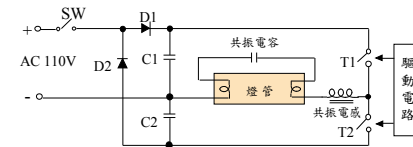


☒ 電子式安定器(電子式日光燈)

- 應用變流器產生高頻交流供給日光燈電源
- 電路結構方塊圖

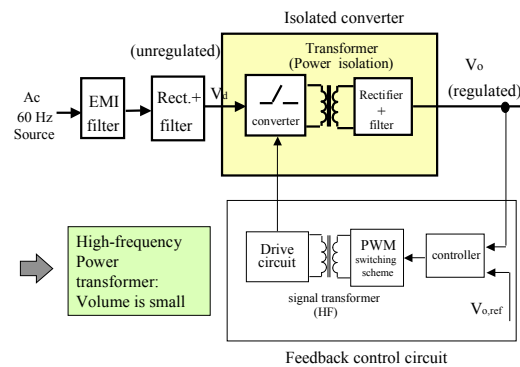


- 半橋式電子式日光燈電路



例子：電源供應器

☒ 隔離式直流切換式電源供應器



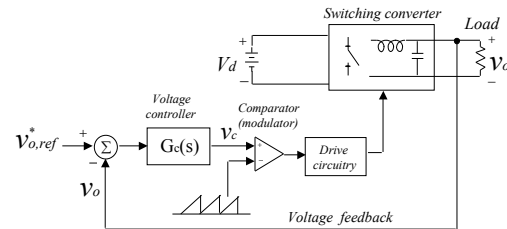
Some isolated converters:

- (1) Flyback converter (Buck-boost derived converter)
- (2) Forward converter (Buck derived converter)
- (3) Push-pull converter (Buck derived converter)
- (4) Half-bridge converter (Buck derived converter)
- (5) Full-bridge converter (Buck derived converter)

☒ 非隔離式直流切換式電壓調節器

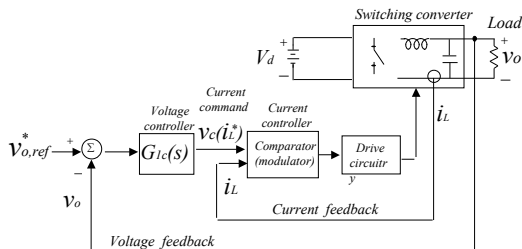
A. 應用 Switching converters: PWM Duty-ratio Control

- Output feedback (single-loop feedback)



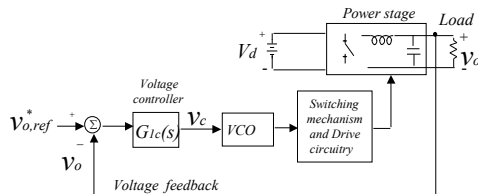
應用 Switching converters : Current-mode Control

- Cascade-control (Multi-loop feedback control)
- When designing the voltage controller, one can set  $I_c = I_L$ , i.e., the system order is reduced by one



B. 應用 Resonant converters

- Zero-voltage switching (ZVS) and/or zero-current switching (ZCS)



☒ 分散式配電系統(Distributed power architecture, DPA)

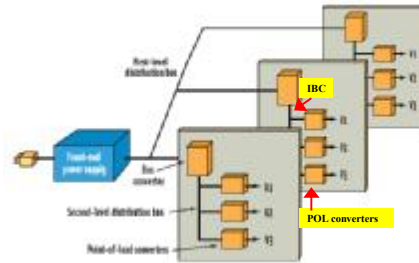
Trends in Communication Power Systems

- Lower voltages, higher currents.
- Distributed power architecture (DPA).
- AC/DC converter (SMR) >> first-level buses DC buses (usually-48V in communication system) >> intermediate bus converters (IBCs) >> Second-level buses (typically 12V) >> DC/DC point-of-load (POL) converters.
- IBC: intermediate bus converter
- POL: point-of-load

## Distributed Power Architecture (DPA)

In a distributed power architecture, a front-end power supply converts ac power to dc and distributes a dc voltage via first-level buses (usually 48 V in communication system) to dc-dc intermediate bus converters (IBC). The IBC's purpose is to first provide isolation, as well as reduce the ac-dc front-end distributed dc voltage to a lower voltage level. This should occur before sending it to a final set of non-isolated dc-dc (buck) converters via second-level distribution buses. These so-called dc-dc point-of-load (POL) converters deliver the required voltages and currents to the system.

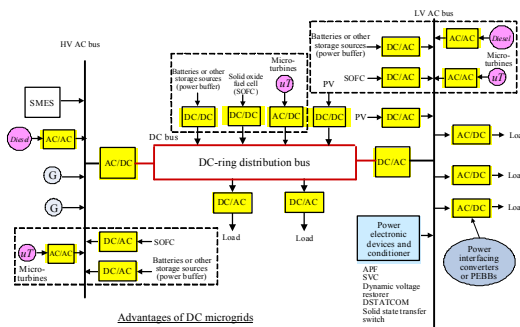
Communications Power Systems 12-V Intermediate Bus Architecture



[www.national.com/appinfo/power/files/BasicDesign\\_HighVoltageComms\\_Feb04.pdf](http://www.national.com/appinfo/power/files/BasicDesign_HighVoltageComms_Feb04.pdf)

## 分散式發電源(Distributed generator, DG) 配電系統、再生式電源(Renewable energy source, RES) 配電系統

### DC and AC Distribution Buses for Distributed Energy Resources (DERs)



**Advantages of DC microgrids**  
 High network quality  
 Higher power transfer capacity  
 Lower disturbance injected in the AC main public network  
 Simplification of converters connecting the DG to the network  
 Simplification of the converters powering the loads

**例子：馬達驅動系統**

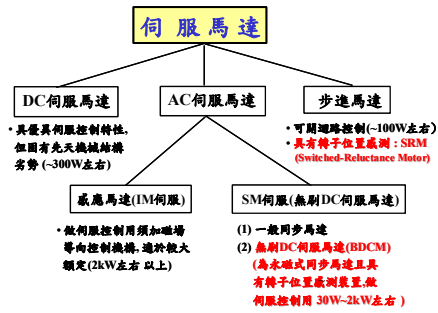
**☒ 分類**

(1) 控制目的分類

- A. 速度控制：又稱速度伺服系統
  - (a) 定速
  - (b) 變速
- B. 位置控制：又稱位置伺服系統
  - (a) 定位控制 - 只控制最後位置
  - (b) 軌跡控制 - 控制路徑

(2) 控制方式

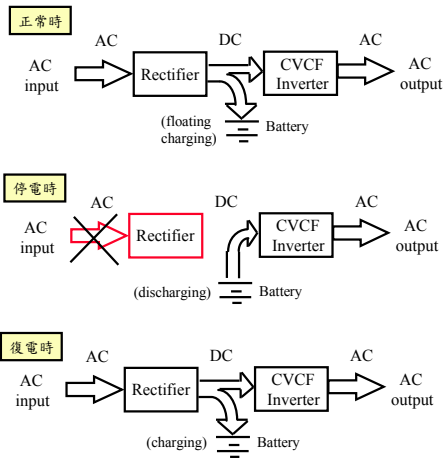
- A. 開環路 (open-loop) 控制系統
- B. 半開環路 (semi closed-loop) 控制系統
- C. 全閉迴路 (closed-loop) 控制系統



**七、電力電子之其它應用**

A、不斷電電源供應器(Uninterruptible power supply, UPS)

● UPS之基本功能



● CVCF inverter: Constant Voltage Constant Frequency inverter